Motivation

A series of mesocosm experiments have been conducted, where enclosed water volumes were disturbed with different carbon dioxide (CO$_2$) concentrations (e.g. Riebesell et al, 2008), simulating possible future atmospheric CO$_2$ conditions. The major benefit of mesocosms is to have controlled, quasi-natural experimental conditions. A mesocosm typically includes a mixture of natural plankton species and thus allows for investigations of CO$_2$-responses on community level. With a data-model synthesis of mesocosm experiments we aim at improving parameterizations and hope to learn about model uncertainties.

EPOCA WorkPackage 9: From process studies to ecosystem models

Physiological modelling (laboratory data) → focus on pH-sensitive calcification & pCO$_2$ dependent growth rates

Ecosystem modelling (mesocosm data) → focus on carbon- & nitrogen uptake

3D-modelling of German Bight (MAECS, HZG) & North Atlantic/ North Sea (at GEOMAR Kiel) (field data) → focus on carbon- & nitrogen fluxes

We first parameterize algal physiological processes and investigate their effects on plankton community level and on biogeochemical cycling. We then specify uncertainties of these model parameterizations and analyse variability in observations. Variability and model uncertainties are related to the strength of a pure pH-response signal (e.g. in calcification). Our results are used to advance the credibility of large-scale, future model projections of ocean acidification effects.

Data-model synthesis of the first Pelagic CO$_2$ Enrichment Study (PeECE-I) in Bergen

Why data from PeECE-I (Dellie et al., 2005; Engel et al., 2005)?

→ well constrained carbonate system, with three mesocosms per treatment (three treatments: low pCO$_2$ = 200 µatm; medium pCO$_2$ = 400 µatm; high pCO$_2$ = 700 µatm)

→ detectable pH/CO$_2$ response signal in calcification (formation of particulate inorganic carbon, PIC)

Variability (pronounced in PIC) can be explained/simulated with small variations in initial plankton composition, identical for all CO$_2$-treatments.

Model simulations that resolve the observed variability allow us to extract the pure ocean acidification effect. This way we specified the CO$_2$ response signal and can relate it to variations in plankton composition and to model uncertainties. Our data-model analysis recalls that smallest variations in initial conditions (during the filling of the mesocosms) translate into large variability on plankton community level.

Conclusions

→ variability and uncertainty in model projections are larger than the variational range of the acidification response signal

→ variability observed during PeECE-I can be explained with tiny variations in initial plankton composition

→ variability on plankton community level must be accounted for in future projections of ocean acidification effects on marine ecosystem dynamics